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## ORIGINAL ARTICLE

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# Imaging in Acute Appendicitis: Lessons Learned from Appendicectomy Patients at Two District General Hospitals in the United Kingdom over a Six-year Period

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### ABSTRACT

**Objective:** To evaluate the utilisation and diagnostic accuracy of imaging for suspected appendicitis, in the context of the negative appendicectomy rate (NAR).

**Methods:** A database was compiled of patients who underwent appendicectomy for suspected appendicitis over a 6-year period at two district general hospitals in the United Kingdom. Data were collected about the imaging performed: abdominal radiograph (AXR), transabdominal ultrasound (TAUS), transvaginal ultrasound (TVUS), or computed tomography of the abdomen and pelvis (CTAP). Results were compared with histology, and data analysed by sex in four age cohorts: 0-16, 17-30, 31-59, and ≥60 years.

**Results:** A total of 2017 patients (1023 female and 994 male) underwent appendicectomy. Overall, 759 (37.6%) patients underwent preoperative imaging (415 AXR, 348 TAUS, 88 TVUS, and 141 CTAP). TAUS use in females was 22.9%, 35.2%, 24.7%, and 15.9% in the 0-16, 17-30, 31-59, and ≥60 years age-groups, respectively. Respective TAUS use in men was 7.8%, 5.3%, 7.1%, and 9.2%. TAUS had a sensitivity of 72.3%, and positive predictive value (PPV) of 82.9%. CTAP use was 1.9%, 7.7%, and 32.4% in the <30, 31-59, and ≥60 years age-groups, respectively. CTAP had a sensitivity of 94.0%, and PPV of 90.4%. AXR and TVUS showed low sensitivity (6.2% and 21.8%, respectively). The overall NAR was 27.3%. The highest NAR was in women aged 17-30 years (42.8%), the lowest NAR was in women aged ≥60 years (12.4%) and boys (18.1%).

**Conclusion:** The NAR is higher in the current study in which use of imaging is less prevalent when compared with previously published studies. Our results suggest that imaging should be performed preoperatively. We recommend TAUS to be the first-line investigation in particular for patients aged <30 years. CT should be considered as an alternative for adults of all ages, in particular low-dose focused abdominal CT, which has been shown to have similar diagnostic performance in appendicitis compared to conventional CT.

**Key Words:** Appendicitis; Diagnostic Imaging; Multidetector computed tomography; Radiography; Ultrasonography

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## 中文摘要

### 急性闌尾炎成像：英國兩間分區醫院六年間經驗的分享

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**目的：**按陰性闌尾切除率（NAR）評估影像學對於懷疑闌尾炎個案的使用和診斷準確性。

**方法：**搜集並結合英國兩間分區醫院於6年期間，對懷疑闌尾炎個案作闌尾切除術的數據。收集有關影像學檢查，包括腹部平片（AXR）、腹部超聲（TAUS）、經陰道作超聲檢查（TVUS），以及腹部和骨盆的電腦斷層掃描（CTAP）。比較影像學檢查與組織學的結果，並分析性別和四個年齡組別的數據：0-16、17-30、31-59和60歲或以上。

**結果：**研究期間進行闌尾切除術共2017例（994名男性和1023名女性）。當中759人（37.6%）接受術前成像檢查：AXR415例、TAUS348例、TVUS88例、CTAP141例。0-16、17-30、31-59和60歲或以上女性的TAUS使用率依次為22.9%、35.2%、24.7%和15.9%；男性的相應TAUS使用率為7.8%、5.3%、7.1%和9.2%。TAUS的靈敏度為72.3%，陽性預測值為82.9%。CTAP在年齡組別<30、31-59和60歲或以上的使用率依次為1.9%、7.7%和32.4%。CTAP的靈敏度為94.0%，陽性預測值為90.4%。AXR和TVUS呈低靈敏度（分別為6.2%和21.8%）。總陰性闌尾切除率為27.3%。最高陰性闌尾切除率是17-30歲的女性（42.8%），最低陰性闌尾切除率是60歲或以上的女性（12.4%）和男孩（18.1%）。

**結論：**與文獻所記載的研究比較，我們使用影像學的次數不及其他機構，而本研究的陰性闌尾切除率較高。這研究的結果顯示應進行術前影像學檢查。我們建議使用TAUS作為一線檢測，特別是30歲以下的病人。對於成年病人，可考慮使用CT，尤其是低劑量腹部CT，因其與傳統CT診斷闌尾炎的表現相若。

## INTRODUCTION

Historically, the diagnosis of appendicitis has been made clinically. Since the late 1990s, however, computed tomography of the abdomen and pelvis (CTAP) and transabdominal ultrasound (TAUS) have been used more frequently to diagnose the condition. The use of CTAP has been most apparent in the United States.<sup>1-3</sup> In the UK, and particularly in a community hospital setting, the use of additional imaging has been more selective. Authors of published studies argue that increased utilisation of computed tomography (CT) and ultrasound has brought about a reduction in the negative appendectomy rate (NAR). Utilisation of CTAP and/or TAUS in more than 80% of suspected appendicitis cases is a feature of several series, with quoted NAR levels of <5%.<sup>4-7</sup>

The sensitivity and specificity of CTAP in suspected appendicitis have been estimated to exceed 90%, however, data obtained for diagnostic performance of TAUS has shown a greater range in sensitivity

and specificity for this modality in the diagnosis of appendicitis (sensitivity, 47.8%-91%; specificity, 72%-91%).<sup>4,8-16</sup>

In other papers, particularly those based in a community setting, results have been different, with lower figures being quoted for the above parameters. There has also been research, particularly among children, which suggests that imaging has not achieved improvements in the diagnosis of appendicitis and, ultimately, the NAR.<sup>17-20</sup>

There is little evidence to support the use of transvaginal ultrasound (TVUS) in the context of appendicitis. Although abdominal X-ray (AXR) is often requested in patients with right-sided abdominal pain, it only has limited value.<sup>21</sup>

There is increasing awareness of the hazards of ionising radiation associated with CT but evidence implies that its use can significantly reduce the rate of NAR.<sup>22</sup> There

is nonetheless a need for its use to be rationed.

We performed a retrospective study of all appendectomy patients at two community hospitals in the UK over a 6-year period, within the same NHS trust. The aims of this study were to (1) evaluate the utilisation of CTAP, TAUS, TVUS, and AXR in patients with suspected appendicitis in various age-groups, (2) ascertain the NAR in those age-groups, and (3) evaluate the diagnostic performance of imaging modalities.

**METHODS**

Data from two district general hospitals within the same NHS Trust were obtained retrospectively from clinical coding and the hospital intranet information system. Data from all non-incidental appendectomies performed within the trust between 1 January 2006 and 1 October 2011 were collected. Demographic information, radiological interpretations, histological findings, and indication for surgery relating to that inpatient episode were obtained. Histopathology reports were all verified by a consultant histopathologist. Reports were classed into two categories:

- Appendicitis — recorded as acute inflammation with or without haemorrhage, necrosis, gangrene, perforation or abscess with subserosal inflammation;
- Negative appendectomy — normal-tissue morphology.

Other histological findings were excluded from statistical analysis, such as neoplasm (including carcinoid tumour) and fibrosis. Radiological interpretation, based on established sets of diagnostic criteria, was obtained and classified as diagnostic for appendicitis, normal, non-diagnostic, or alternative

diagnosis (without appendicitis).<sup>23-25</sup> For AXR, imaging not showing evidence of appendicitis was grouped together as normal. A full list of diagnostic criteria is shown in Table 1. Diagnostic criteria were based on the best available evidence from the current literature.<sup>1,8,15,21,23,24</sup> Final and validated radiological reports were correlated with histopathological findings.

Results were analysed as separate cohorts based on sex and age, and also as one cohort. Age-groups chosen were paediatric patients (0-16 years), young adults (17-30 years), older adults (31-59 years), and older patients (≥60 years — the age of commencement of colorectal cancer screening in the UK).

**Statistical Analysis**

The sensitivity and positive predictive value (PPV) for CTAP, TAUS, TVUS, and AXR were calculated through statistical analysis. Logistic regression analysis was performed to account for the influence of the following variables with reference to likelihood of negative appendectomy: age-group, gender, and utilisation of imaging. The significance of each variable was evaluated using the chi-square test, and from this, odds ratios (ORs) constructed with 95% confidence intervals.

**RESULTS**

Within the study period, 2173 patients underwent appendectomy: 1045 male (48.1%) and 1128 female (51.9%). Of all the appendectomies, 156 yielded an alternative histology result and were excluded from analysis, producing an overall sample size of 2017. Results by age and sex cohort concerning histology results and imaging performed are shown in Table

**Table 1.** Diagnostic criteria for imaging modality.

Imaging modality	Diagnostic criteria
AXR	Small bowel dilatation in the presence of a faecolith
TAUS and TVUS	Blind-ended, tubular, uncompressible, aperistaltic structure Maximum appendiceal diameter >6 mm Increased periappendiceal echogenicity Echogenic appendicolith with distal shadowing
CTAP	Circumferentially hyperaemic flow of appendix Maximum diameter of appendix >6 mm Maximum wall thickness of appendix >3 mm Appendiceal wall enhancement Focal caecal wall thickening Maximum depth of intraluminal appendiceal fluid >2.6 mm

Abbreviations: AXR = abdominal X-ray; CTAP = computed tomography of the abdomen and pelvis; TAUS = transabdominal ultrasound; TVUS = transvaginal ultrasound.

**Table 2.** Imaging performed and histology by age cohort.\*

Imaging modality / histology	Age-group (years), No. (%)								Total
	Males				Females				
	0-16	17-30	31-59	≥60	0-16	17-30	31-59	≥60	
Total	270	304	311	109	231	383	296	113	2017
Histology									
Histology +	221	236	257	87	137	219	211	99	1467
Histology -	49 (18.1)	68 (22.4)	54 (17.4)	22 (20.2)	94 (40.7)	164 (42.8)	85 (28.7)	14 (12.4)	550 (27.3)
Imaging	32 (11.9)	80 (26.3)	106 (34.1)	75 (68.8)	62 (26.8)	175 (45.7)	147 (49.7)	82 (72.6)	759 (37.6)
No imaging: total	238	224	205	34	169	208	149	31	1258
Histology +	196	178	172	24	107	130	106	26	939 (74.6)
Histology -	42 (17.6)	46 (20.5)	33 (16.1)	10 (29.4)	62 (36.7)	78 (37.5)	43 (28.9)	5 (16.1)	319 (25.4)
TAUS									
TAUS: total	21 (7.8)	16 (5.3)	22 (7.1)	10 (9.2)	53 (22.9)	135 (35.2)	73 (24.7)	18 (15.9)	348 (17.3)
TAUS +, histology +	8	6	9	6	17	29	25	7	107
TAUS +, histology -	1	2	1	0	3	10	5	0	22
TAUS -, histology +	2	2	4	2	2	18	8	3	41
TAUS -, histology -	0	2	3	0	8	29	6	3	51
TAUS non-diagnostic	7 (33.3)	4 (25)	4 (18.2)	2 (20)	23 (43.4)	45 (33.3)	25 (34.2)	2 (11.1)	112 (32.2)
CTAP									
CTAP: total	2 (0.7)	7 (2.3)	27 (8.7)	33 (30.3)	6 (2.6)	7 (1.8)	20 (6.8)	39 (34.5)	141 (7.0)
CTAP +, histology +	1	3	18	25	2	2	11	32	94
CTAP +, histology -	0	2	2	1	1	0	2	2	10
CTAP -, histology +	0	2	1	0	1	1	1	0	6
CTAP -, histology -	0	0	1	2	0	1	2	0	6
CTAP non-diagnostic	0 (0)	0 (0)	1 (3.7)	0 (0)	1 (16.7)	0 (0)	0 (0)	0 (0)	2 (1.4)
AXR									
AXR: total	16 (5.9)	67 (22.0)	78 (25.1)	60 (55.0)	7 (3.0)	53 (13.3)	71 (24.0)	63 (55.8)	415 (20.6)
AXR +, histology +	0	5	3	7	0	1	1	1	18
AXR -, histology -	0	2	0	1	0	0	0	1	4
AXR non-diagnostic	15 (93.8)	56 (83.6)	67 (85.9)	42 (70)	6 (85.7)	48 (94.1)	67 (94.4)	55 (87.3)	356 (85.8)
TVUS									
TVUS: total	0	0	0	0	4 (1.7)	43 (11.2)	37 (12.5)	4 (3.5)	88 (8.6)
TVUS +, histology +	0	0	0	0	0	4	3	0	7
TVUS +, histology -	0	0	0	0	0	0	1	0	1
TVUS -, histology +	0	0	0	0	0	12	10	3	25
TVUS -, histology -	0	0	0	0	1	21	8	1	31
TVUS non-diagnostic	0	0	0	0	3 (75.0)	2 (4.7)	10 (27.0)	0 (0)	15 (17.0)

Abbreviations: AXR = abdominal X-ray; CTAP = computed tomography of the abdomen and pelvis; TAUS = transabdominal ultrasound; TVUS = transvaginal ultrasound; + = positive scan for appendicitis; - = negative scan for appendicitis.

\* Alternative diagnosis (other than appendicitis + or appendicitis -) by different imaging methods is not included.

2. NAR according to imaging performed is shown in Table 3. AXR and TVUS have been excluded from this table for reasons of poor diagnostic performance in the context of appendicitis. Histology from 550 patients revealed normal appendix morphology, yielding an NAR of 27.3%. The rate was higher in females (34.9%) than in males (19.4%). In the paediatric population, negative appendicectomy was far less frequent in boys than in girls, with rates of 18.1% and 40.7%, respectively. The highest NAR was seen in women aged 17-30 years at 42.8%, compared with 22.4% for men in the same age-group.

Some form of imaging was performed in 759 (37.6%)

patients and no imaging in 1258 (62.4%); 415 AXR, 141 CTAP, 348 TAUS, and 88 TVUS were performed (some patients underwent more than one type of

**Table 3.** Negative appendicectomy rate by imaging group.

Imaging performed	Negative appendicectomy rate (95% CI)
No imaging	29% (26-32)
CTAP and TAUS	33% (29-37)
CTAP only	19% (13-25)
TAUS only	40% (35-45)

Abbreviations: CI = confidence interval; CTAP = computed tomography of the abdomen and pelvis; TAUS = transabdominal ultrasound.

imaging test). Of the 156 patients excluded from analysis due to alternative histology, 15 were diagnosed with carcinoid tumours and 90 with fibrotic appendix. Logistic regression analysis and the chi-square test revealed that the factors with the greatest association with negative appendectomy were female gender, followed by younger age ( $p < 0.0001$ ). For the purposes of this analysis, TVUS and AXR were excluded due to significantly inferior diagnostic performance. Despite only including radiology with superior diagnostic performance, the utilisation of imaging was not shown to have a significant association with negative appendectomy.

The OR of negative appendectomy in females was 3.1 times that of males. The OR for females aged 0-16 years versus males of the same age was 2.4, and in the 17-30 years' age-group, 2.2. The OR of negative appendectomy in the 0-16 years' age-group versus those in the >60 years age-group was 4.9. ORs for gender and age-groups are detailed in Table 4.

**Use and Performance of Imaging Modality**

***Abdominal X-ray***

AXR was the most frequently used imaging, performed in 20.6% of patients ( $n = 415$ ). AXR was used sparingly in the paediatric population (5.9% for males, 3.0% for females). The use of AXR increased with age, with over 50% of patients for both genders >60 years of age undergoing the investigation. In total, 33 (8.0%) AXRs were classified as diagnostic. In the context of a diagnostic result, the PPV of AXR was 81.8%. The majority of AXRs were normal — 356 (85.8%), yielding a sensitivity of 6.2%. Alternative diagnoses were seen in 37 patients; the most frequent was small bowel dilatation (without an appendicolith), present in 27 (6.5%) patients. Of these, 24 had appendicitis on histology.

***Transabdominal Ultrasound***

TAUS was performed in 348 patients (279 female and

69 male); 6.9% of males underwent TAUS, compared with 27.3% of females. In the paediatric population, 7.8% of males and 22.9% of females were assessed using TAUS. For women who underwent TAUS, 35.2% aged 17-30 years, 24.7% aged 31-59 years, and 15.9% aged  $\geq 60$  years. Of the TAUS scans, 129 were classified as 'diagnostic', of which 82.9% correlated with appendicitis on histology; 92 were reported as normal; 44.6% of the specimens obtained from these patients were positive for appendicitis. The above figures yielded a sensitivity of 72.3% for TAUS, with a PPV for a diagnostic scan of 82.9%. Of the TAUS performed, 112 (32.2%) were non-diagnostic where the appendix was not visualised. An alternative diagnosis was made using this modality in 15 patients and included ovarian cysts and Crohn's disease. Histology from 11 of these specimens ultimately proved positive for appendicitis.

***Transvaginal Ultrasound***

TVUS was performed in 88 (8.6%) women. Its use was sparse in the paediatric (1.7%) and elderly (3.5%) populations. The majority were performed in those aged 17-30 years (11.2%) and 31-59 years (12.5%). Eight scans were considered diagnostic, of which seven displayed appendicitis on histology. Overall, 56 scans were reported as normal; of these, 25 had histology positive for appendicitis. These figures yield a sensitivity of 21.8% for TVUS, with a PPV of 87.5% for a diagnostic scan. Of the TVUS scans performed, 15 (17.0%) were reported as non-diagnostic. An alternative diagnosis was made in nine patients and included ovarian cysts and uterine fibroids; five of these patients ultimately had appendicitis on histology.

***Computed Tomography of the Abdomen and Pelvis***

CTAP was performed in 141 (7.0%) patients, with similar use in both sexes. CTAP use in patients aged <30 years was very low: less than 3% in all age-groups. Utilisation of CTAP increased in older cohorts: 8.7% of males and 6.8% of females underwent CTAP in

**Table 4.** Logistic regression analysis on odds of negative appendectomy.

Cohort	Odds ratio	95% CI	p Value
Female vs. male (total)	3.1	2.2-4.0	<0.0001
Female 0-16 years vs. male 0-16 years	2.4	1.8-2.8	<0.0001
Female 17-30 years vs. male 17-30 years	2.2	1.6-2.4	<0.0001
Female 31-59 years vs. male 31-59 years	1.8	1.5-2.4	<0.0001
Male $\geq 60$ years vs. female $\geq 60$ years	1.4	1.1-1.8	<0.0001
Both genders 0-16 years vs. both genders $\geq 60$ years	4.9	3.8-6.0	<0.0001

Abbreviation: CI = confidence interval.

the 31-59 years' age-group compared with the  $\geq 60$  years' cohort, wherein 30.3% of males and 34.5% of females underwent CTAP. Of the CTAP scans performed, 104 were diagnostic, of which 90.4% had a positive histological specimen. A normal appendix was identified on the scans of 12 patients of whom six had appendicitis on histology. The numbers above equate to a sensitivity of 94.0% for CTAP, and a PPV of 90.4%. Two (1.4%) CTAP scans were reported as non-diagnostic. An alternative diagnosis to appendicitis was suggested by 23 scans of which 13 subsequently displayed appendicitis on histology, four of which indicated small bowel dilatation.

## DISCUSSION

Many studies have evaluated the use of imaging in appendicitis. Several have been multicentre- or academic centre-based and comprised large sample sizes.<sup>8-16</sup> Smaller studies have been based at a community hospital level.<sup>17-20</sup> The authors believe that this is the largest study of its type performed both in the UK and in a community hospital setting. This study found an overall NAR of 27.3%. This is higher than that published elsewhere. It has also established that the NAR is particularly high in women in younger age-groups. The use of imaging, specifically CTAP and TAUS, is lower than that in published studies from other countries.<sup>4,13</sup> The use of radiological imaging among children who had an appendectomy was very low. The authors believe that practice in their trust is representative of activity within community hospitals across the UK.

Although the use of imaging did not have a statistically significant association with NAR in this study, the authors believe that one of the possible reasons behind the high NAR is the low use of CTAP and TAUS. Published research has identified substantially reduced NAR with high utilisation of CTAP or TAUS in suspected appendicitis. Several papers report imaging rates of over 80% compared with this study: 7% for CTAP and 17.3% for TAUS.<sup>3-6</sup>

A large, multicentre-based trial in the United States by Drake et al<sup>4</sup> of over 19,000 patients revealed that 91% of patients underwent either TAUS or CTAP. The comparatively low NAR of 5.4% in this study was largely attributed to increased use of imaging.<sup>4</sup> This is not a consensus view, however. Many studies suggest increased rates of imaging have had negligible, if any, effect on the NAR. A large retrospective review of more

than 55,000 patients by Bachur et al<sup>18</sup> found that CT had a negligible effect in certain paediatric age-groups. In a smaller study of 616 patients, Partrick et al<sup>19</sup> concluded the same for all children as did Huynh et al<sup>17</sup> for patients of all age-groups with suspected appendicitis.

Consistent with several studies, this paper has shown a high sensitivity and PPV for CTAP, even though the numbers are small. Our figures lie within the range of published data.<sup>4,6,10,13,26</sup> The limited use of CTAP in the UK may, in part, be due to variation in its availability across the country.<sup>27</sup> A major justification is the wish to limit ionising radiation exposure, particularly in children.

Recent literature has determined that diagnostic performance of low-dose focused abdominal CT is comparable with conventional CTAP techniques in the context of appendicitis. This has also been demonstrated with techniques that avoid intravenous contrast.<sup>28-30</sup> It therefore seems reasonable to include low-dose focused CT in a stepwise algorithm of investigation of appendicitis.

TAUS exhibited a lower sensitivity and PPV than CTAP in this study: 72.3% versus 82.9% respectively. A large proportion (32.2%) was nonetheless non-diagnostic. Our data are comparable with research conducted in other community hospital settings, although not with those in academic centres.<sup>12,14,15,31,32</sup> Our results also indicate that the NAR in patients undergoing TAUS alone was higher than that in patients who received no preoperative imaging (40% vs. 29%). There are several possible reasons for this. First, these figures do not account for patient age and sex and a higher proportion of young adult females, in whom the NAR has been shown to be highest, underwent preoperative TAUS. Second, a cohort within the patients not receiving imaging may have presented with clear clinical and biochemical features of acute appendicitis. Third, this result may in part be due to the operator-dependent nature of ultrasound (academic centres perhaps being more likely to have specialist sonographers available) and the inherent limitations of ultrasound itself (image quality may be poor in patients with large body habitus, difficulty in visualising a retrocaecal appendix etc).

This paper has also identified that TAUS is seldom used in children, particularly in boys — a demographic group where the modality has been shown to be effective.<sup>8,12,14</sup> Given the high PPV of TAUS, lack of radiation, and

reported diagnostic performance, there is a strong evidence to support its use as an initial investigation in the paediatric and young adult age-groups.

TVUS has proven to be of little diagnostic value in the context of appendicitis. While exhibiting a high PPV, statistical analysis placed sensitivity at 21.8% in the presence of a high non-diagnostic rate (16.1%). There have been studies with very limited sample sizes that suggest combining TAUS and TVUS is potentially diagnostically useful, but our data do not support this.<sup>16,33</sup>

The poor diagnostic performance of TVUS is expected given that its primary role is to identify gynaecological pathology as a cause for symptoms in the context of right iliac fossa pain. Less than 10% of patients in this study had a gynaecological pathology identified using this modality, of whom half had appendicitis on histology. To a large degree, this negates its value when used on this basis.

AXR has been shown to be used widely, particularly with increasing age, but adds little in the identification or exclusion of appendicitis. Whilst a diagnostic X-ray yields a high PPV, the vast majority are non-diagnostic, and the sensitivity of this modality is very low. AXRs that show small bowel dilatation without a faecolith in the context of right iliac fossa pain seem to be a reasonable indicator of appendicitis. These seem nonetheless to be an infrequent occurrence.

### Limitations

There are several limitations in this study. Rationale as to why imaging was performed, and what imaging was performed was not considered. This includes both clinical observations and haematological results. This paper also did not take into account the impact of laparoscopy. Although patients who underwent laparoscopy and subsequent appendicectomy were included, those who had a negative laparoscopy or gynaecological pathology were not. Only patients who underwent appendicectomy were included. Moreover, patients investigated for appendicitis where an alternative diagnosis was reached were not considered. Those who had imaging suspicious of appendicitis without proceeding to appendicectomy were also not included (due to difficulty in identifying such patients in the context of a retrospective evaluation). Therefore, calculations concerning specificity and negative predictive value could not be made. The number

of children who underwent imaging was also low, limiting conclusions that can be drawn in this cohort. Finally, our paper was confined by the limitations of its retrospective nature.

Given the findings of the study, the authors have arrived at the following:

- In children, and adults younger than 30 years, a TAUS performed as the primary investigation may be of considerable use. A scan positive for appendicitis may render a subsequent CTAP unnecessary.
- Where TAUS is non-diagnostic or normal and pain persists, CTAP should be performed. In the younger cohort (<30 years old), a focused low-dose CTAP may suffice. Depending on the individual case, a formal abdominal protocol CTAP may be indicated.
- Patients older than 60 years should be considered for formal abdominal protocol post-intravenous contrast CT at the outset.
- A TVUS could be used in the holistic work-up of abdominal pain in females, but demonstration of gynaecological pathology cannot exclude appendicitis.
- An AXR very rarely contributes to the diagnosis of appendicitis. Even so, it can be a useful screening tool for intra-abdominal pathology, particularly in those aged >30 years.

### CONCLUSION

The authors believe that this paper contributes information regarding the management of patients with suspected appendicitis in the UK. It provides figures for diagnostic performance of different imaging modalities in a community hospital setting. It further highlights the difficulties in diagnosing appendicitis. The balance between reducing unnecessary surgical procedures and the risks of ionising radiation remains challenging. We could, nonetheless, be doing better, and believe that increased use of selective imaging can reduce the NAR.

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